Abstract: We propose to measure the transition amplitudes of the $\Delta(1232)$ resonance at $Q^2 = 4\ GeV^2/c^2$. In particular we will measure the kinematically complete reaction $p(e,e'p)\pi^\circ$ at excitation energies covering the $\Delta(1232)$, obtaining nearly a full 4π angular distribution of the $p-\pi^\circ$ in the Δ rest frame. The experiment will be carried out in Hall-C using the Short Orbit Spectrometer (SOS) to detect the scattered electrons, and the High Momentum Spectrometer (HMS) to detect the proton. At these cm energies only single meson production is kinematically allowed. However the π° will be definitely identified by missing mass reconstruction. We will obtain information about the transition multipole amplitudes for this reaction in a kinematic region never previously accessed. An important goal will be to assess the relative importance of the contributing amplitudes M_{1+} , E_{1+} and S_{1+}. At low Q^2 in the region where the constituent quark model works well, the M_{1+} amplitude dominates and the E_{1+} and S_{1+} are small. At increasing Q^2 there is no reason to expect E_{1+} to remain small. Indeed, an increasing E_{1+} would be the signature of the breakdown of the constituent quark model as a basis for describing the properties of baryons, and is fully expected by theoretical models.

The experiment is will utilize a 4 GeV, 100 μA beam, and 4 cm liquid hydrogen target. There will be one setting of the electron spectrometer which defines Q^2. In order to cover the 4π decay of the delta it will be necessary to have up to 4 angular settings of the proton spectrometer to cover the full range of proton momenta. The experiment will use only the initial complement of equipment in Hall C, with no further additions or modifications. Data collection time will be about 10 ***days*** (240 ***hrs***). The total request including contingency is 300 ***hrs***.

I. Proposal Summary

This experiment will measure exclusive single π° production on protons in the excitation region of the $\Delta(1232)$ resonance at $Q^2 = 4\ GeV^2/c^2$. The experiment will be carried out in Hall-C using the Short Orbit Spectrometer (SOS) to detect the scattered electrons, and the High Momentum Spectrometer (HMS) to detect the recoiling proton. The emitted pions will be identified by missing mass reconstruction. We will study the short range structure of the Δ resonance in a kinematic region which has never before been studied by exclusive coincidence reactions. A specific goal is to identify the transition from the $non-perturbative\ QCD$ regime , where theoretical descriptions have used constituent quark models (CQM), toward a physical region where CQM no longer apply, and different degrees of freedom are necessary to describe the experimental results. There is evidence that for baryons this transition already may be occurring at $Q^2 \sim 2$ or 3 GeV^2/c^2, which is comfortably below the Q^2 of this proposal. A unique feature of the $\Delta(1232)$ which we would like to understand is the decrease in the form factor as a function of Q^2 relative to the other known resonances, both in the low Q^2 $non-perturbative$ region as well as in the transition region where different physics is likely to play a role.

A specific signature for the breakdown of the CQM is the evolution of the contributing amplitudes from those predicted by CQM's. In particular the existence of a sizeable E_{1+} amplitude is one such signature. As will be seen in Section IV, the ability to observe